

Environmental management of the water supply of Cidade Universitária Prof. José da Silveira Netto (UFPA) and implementation model for granting water use

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Abstract: This study was carried out in the Prof. José da Silveira Netto University City, on the campus of the Federal University of Pará (UFPA), on the evaluation of the environmental management of water supply and the normative status of models for granting the right to use water resources in the administrative body, the State Secretariat for the Environment and Sustainable Development (SEMAS/PA). The aim of the study is to propose necessary procedures for implementing a project to support good environmental management of urban sanitation systems, based on SEMAS/PA Normative Instruction no. 3 of March 26, 2014. The methodology was developed through documentary/bibliographical research and visits to the competent bodies (SEMAS/PA, CPRM and FEMAC) and technical visits to the sectors of the university city. The studies show that the process of environmental management of water resources and the model for granting water rights need to be improved from the outset. The water resource use on the campus of the Federal University of Pará should meet this requirement and comply with the applicable regulations and any technical conditions proposed by the competent environmental protection agency.

Key words: environmental management; water concession; university city

1 Introduction

The granting of the right to use water resources is one of the instruments of the National and State Water Resources Policy and aims to ensure the quantitative and qualitative control of water uses and the effective exercise of water access rights. The user must apply for a permit when abstracting water from a body of water (surface abstraction) or when using water from a well (underground abstraction), for use in agriculture, aquaculture, industry, mining, hydraulic works, water supply, effluent discharge, hydroelectric potential and other uses that alter the regime, quantity and/or quality of water. All users of water resources, with the exception of exempt cases provided for by law and regulations, must contact the management body and apply for a grant to guarantee their rights to use a certain flow or volume of water, or to carry out hydraulic interference such as wells and dams (Pará, 2014a).

Environmental management and regulation of water resources are extremely important, as they promote sustainable development in terms of the social, economic and environmental needs of this resource, while at the same time promoting

harmony between current uses without putting future generations at risk (Ribeiro et al., 2014).

With regard to the granting instrument, Article 12, II of Law 9.433/97 establishes that the rights to the following uses of water resources are subject to granting by the public authorities: the extraction of water from an underground aquifer for final consumption or as an input in a production process (Brasil, 1997). It is important for society to be aware of the importance of groundwater as one of the strategic sources of water resources and its regulatory role, as well as to take care to protect these important sources of water resources, both in quantitative and especially qualitative terms, because once an aquifer has been polluted, its restoration is slow and difficult.

Over the years, the Federal University of Pará (UFPA), an important scientific and academic institution in the Amazon region, has become capable of meeting the institutional demand for undergraduate courses, postgraduate courses, free courses, extension and research projects, interaction with the surrounding community, master's, doctoral and post-doctoral studies. In this context, the need for water has increased due to the increase in the number of people and services offered by this institution, such as: school hospitals, public and private banks, central and sectoral library, university restaurant, living space, as well as the number of university and postgraduate courses.

The general objective of this article is to propose the necessary procedures for implementing the granting instrument for environmental management of the water supply of the José da Silveira Netto university town, based on Normative Instruction No. 3 of 26/03/2014 of the State Secretariat for the Environment and Sustainability (SEMAS/PA) in order to ensure quantitative and qualitative control of water uses and the effective exercise of the right of access to water, in accordance with Law 6.381/2001, which provides for the State Water Resources Policy in the State of Pará (Pará, 2001).

2 Methodology

The design of this research is classified, in terms of its objectives, as exploratory, which, according to Gil (2008, p. 27), seeks not only to obtain a general overview of the subject, but mainly to "develop, clarify and modify concepts and ideas, with a view to formulating researchable problems or hypotheses for further studies".

According to Yin (2005, p. 39), "descriptive, qualitative and research studies of this type are aimed at constructing explanations in order to analyze the data underlying the reality studied". This study was based on a bibliographic survey, which according to Yin (2005, p. 60) "can be done using materials already prepared such as books, research articles, dissertations, mainly in the area of environmental sciences and social sciences, sciences and legal issues, seeking information on social and environmental sustainability from various authors".

It was also based on a documentary survey which, according to Gil (2008) "are materials that have not yet received an analytical treatment, or that can still be reworked according to the research objectives (reports, official documents) in a field research". Bibliographical research, documentary research and direct contact are the three procedures for obtaining data that exist in the scientific method (Marconi & Lakatos, 2003, p. 158).

The methodology was implemented by means of qualitative, quantitative, field, documentary and bibliographic research. Finally, a technical report on drilling carried out by the company FEMAC - Geosolo Engenharia Ltda was researched, this report was provided by the UFPA University Campus City Hall, technical visits were made to the headquarters of the Mineral Resources Research Company (CPRM/PA), as well as direct interviews at SEMAS/PA, and files on administrative and technical procedures available on this environmental agency's own website were researched.

2.1 Study area

This research was carried out at Cidade Universitária Prof. José da Silveira Netto, the headquarters campus of the Federal University of Pará (UFPA). UFPA was created by Law no. 3.191, of July 2, 1957, founded by the President of the Republic Juscelino Kubitschek de Oliveira, and is a federal university organized on a self-sufficient basis, linked to the

Ministry of Education (MEC) through the Higher Education Secretariat (SESu). This IFES is located on the banks of the Guamá River, right on the waterfront, about 10 km from the center of Belém, Pará. It is one of the most important universities in the country and has an urban area of 1,787,085.57 m² and more than 50,000 people pass through it, including students, teaching staff, technical-administrative staff, researchers, guests, communities and others (UFPA, 2018). The university city is located in the Guamá neighborhood and its access roads are: Av. José Bonifácio, Av. Augusto Correa, Av. Perímetro and Av. Bernardo Sayão, Figure 1 below shows the location map of the UFPA university campus.



Figure 1. Location map of the UFPA University Campus Source: Ferreira (2019, p. 64)

In exchange, the campus includes Campus 1 (Primary Sector), Campus 2 (Professional Sector) and Campus 3 (Sector) (Health) and Campus 4 (sports area). Figure 2 shows the sectors correctly positioned throughout the University.



Figure 2. Location of the university city sectors. Source: Adapted from Google Earth (2023)

The groundwater in the geological environment of the section drilled for the construction of the UFPA 06" deep tube well is made up of lithological units known as the Barreiras Group and the Pirabas Formation (FEMAC, 2009). The lithotypes that make up the Pirabas Formation are the ones that offer the best conditions for the accumulation of

groundwater. It has a clastic sequence of great heterogeneity and cyclical intercalations of varying thicknesses of clay, calcareous or non-calcareous sandstones, limestones, marls and shales; some of these sediments are pyritic (rich in iron sulphide), contain fossils, shell fragments, worm tubes, etc. The most significant aquifer systems are located in the 180 to 270 m range. The Barreiras Group is composed of variegated clays, medium sandstones and sandy siltstones of heterogeneous composition, occurring at a depth of between 30 and 100 m, but with high iron contents (Brasil, 2002).

The 12" artesian well, estimated at 250 meters, was drilled in 2009, in the area of the Water Treatment Plant of the University City Technology Center, whose location coordinates (Datum WGS 84) obtained by GPS, are: Geographic: Latitude: 01°28'30"S, Longitude: 48°27'04"O (FEMAC - GeoSolo Engenharia Ltda., 2009). The construction profile of the artesian well is shown in Figure 3, where it can be seen that the total depth of the well is 250.60 m. By observing the figure we can visualize the various types of lithological profiles showing the appropriate geomorphological features for the region.

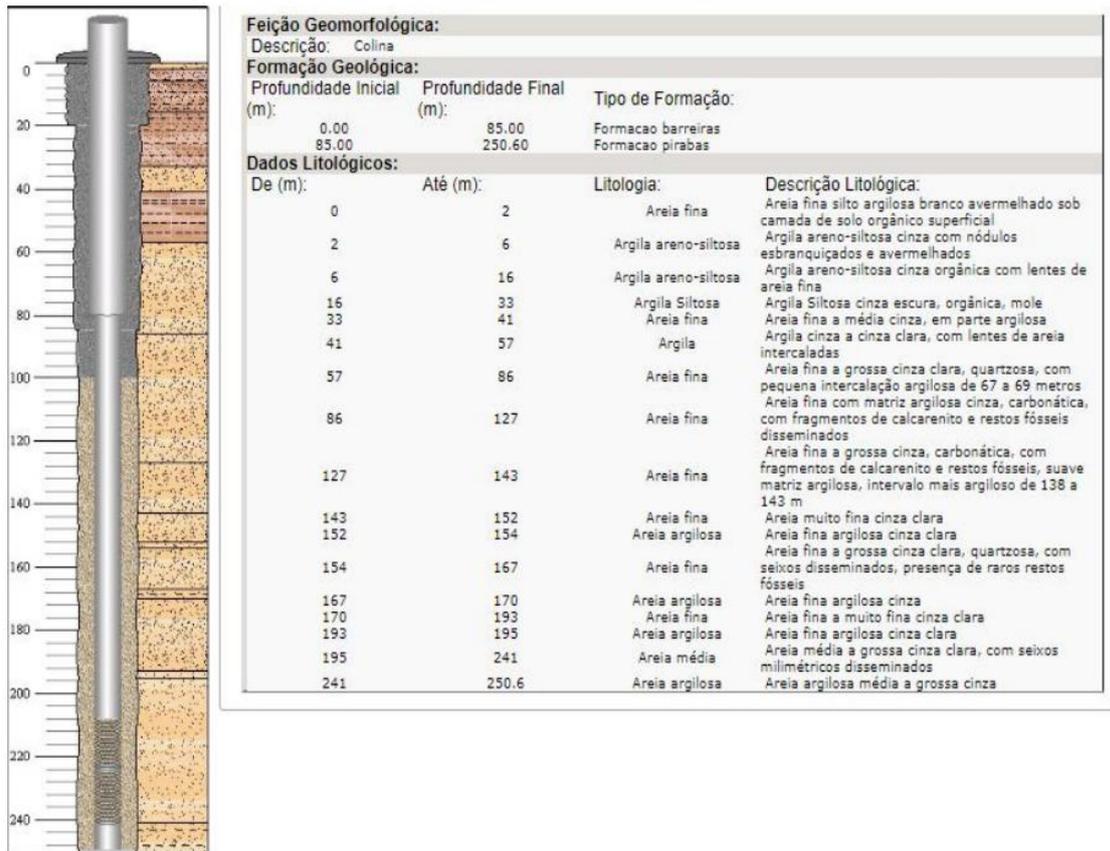


Figure 3. Construction profile of the artesian well on the UFPA campus. Source: CPRM, SIAGAS3(2019)

3 Results and discussion

Based on the results, a model for granting the right to use water resources was proposed. A technical report was drawn up describing the study area, the quality of the water bodies and the requirements for use in the university city, the environmental and hygienic conditions of the fountain, the use model, water tests, the structural profile and the pumping of the well to meet these requirements. As a result, there was an urgent need to suggest to the institution's top administrator, in order to legalize these non-compliant situations, the appointment of a multidisciplinary team of professionals, legally qualified, preferably with the presence of a professional in the fields of geology, chemistry and engineering.

3.1 José da Silveira Netto University city water management and use grant model

Water is fundamental to human survival, the environment and the economy, but nowadays the authorization of its use is regulated by law according to what is known as the granting of the right to use water resources and in order to obtain it,

it is necessary for the technical person responsible for the granting request to duly instruct the process, according to Normative Instruction No. 03 of March 26, 2010 and Terms of Reference (Pará, 2014), both from SEMAS/PA, based on the Model below as shown in Figure 4. This figure shows the various types of documents for the prior or right granting process with the State Secretariat for the Environment and Sustainability of the State of Pará.

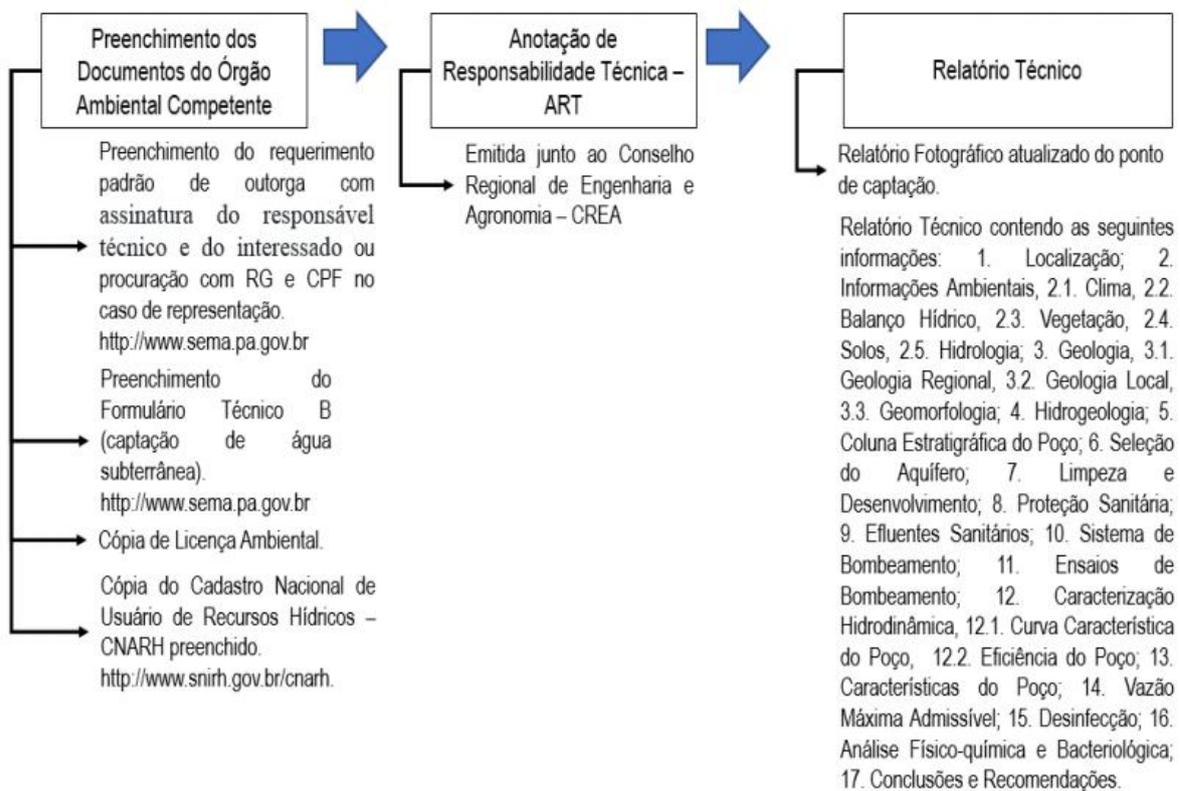


Figure 4. List of documents for requesting a Prior or Right Grant from SEMAS/PA. Source: Modified from SEMAS/PA and adapted by the authors (2023)

3.2 Granting administrative procedures in the State of Pará

The State Water Resources Policy has given SEMAS/PA the task of granting the right to use water resources for rivers in the state's domain. Rivers in the Union's domain are managed by the ANA, in accordance with Law 9.433/1997, in its article 29 (Brasil, 1997).

According to Law 6.381/2001, article 39 III, in implementing the PERH it is the responsibility of the State Executive Branch to grant rights to use water resources, regulate and supervise uses within the scope of its competence. Currently, this policy is coordinated and executed by the Directorate for Water Resources Planning and Management (DIREH), linked to the Deputy Secretary for Water Resources and Climate, which is part of the current SEMAS/PA. The following is a routine of administrative procedures for obtaining the Grant adopted by SEMAS in the State of Pará.

The process begins when the forms filled out by the applicant are sent to the Protocol, accompanied by the technical and legal documentation required by CERH Normative Instruction No. 03 of March 26, 2014, to the SEMAS/PA Water Resources Directorate (DIREH) for analysis by the Grant Management Department (GEOUT), which may be granted, rejected or archived. According to article 8 of the above IN, during the technical analysis, SEMAS/PA may ask for new documents to be added or for further clarifications to be provided, in the form and within the timeframe defined in the notification, taking into account the specifics of the case. If the interested party partially complies with the pending notification and the deadline for compliance is not extended, the process will be rejected, and the managing body must

inform the interested party, by means of a notification, of the rejection of the request and the consequent archiving of the process. (IN 03 of 2014, art. 8, § 3, art. 9). If the application is approved, it is granted the titles of Prior Grant, Grant of Right or Declaration of Waiver of Grant (Pará, 2014).

It should be noted that in order to file a request for the use of water resources, it is necessary to have already registered with CNARH/REGLA and paid the State Collection Document (DAE), which must be downloaded from the website of the Pará State Department of Finance (Pará, 2019), and collected under Code 1289, which will vary according to the flow rate to be captured from the desired area. The amount will be in R\$800.00 (eight hundred reais) to R\$10,000.00 (ten thousand reais) (Nascimento, 2019).

The process usually takes 6 months to be analyzed and approved. Once the information is complete, the process is submitted to a technical evaluation, with the respective opinion being issued, where it is possible to monitor the grant request electronically, available on the SEMAS/PA website, through the State Water Resources Information System (SEIRH) (Nascimento, 2019). In the event of a favorable decision, the Preliminary Grant, Right to Grant or Declaration of Waiver of Grant is granted, signed and published in the Official Gazette and at least one newspaper with wide circulation in the state of Pará. In the case of a grant of right of use, the user must comply with the specific conditions for each type throughout the term of the permit, such as cleaning and disinfecting the well for underground abstraction, water analysis which must be carried out periodically every 6 months and presented annually, as well as a history of the flow and volume of water abstracted, etc. According to Article 1 § 1 and § 2 of CERH Resolution No. 09 of October 18, 2010, insignificant users must apply to SEMAS/PA for a declaration of exemption from granting, which must be filed on a form made available by the agency.

As of November 2017, in the case of the ANA and the states of Maranhão, Pará, Piauí, Rio de Janeiro, Rio Grande do Norte and Tocantins, the user will have to apply directly to the new Federal Use Regulation System (REGLA), which is an integral part of the National Water Resources Information System - SNIRH, i.e.

Registration of uses and interferences in surface water and groundwater under the domain of the above states must be done through the REGLA system. After issuing the grant, the managing body must register the data of the regularized users in the CNARH. (ANA, 2017, p.103). According to the ANA, REGLA is a new tool for applying for the right to use water resources in the Union's domain. This system streamlines the process of requesting and analyzing grant applications at the ANA. Regularization requests are made online, by interference (abstraction, release, dam) and, for most purposes, without the need to send paper documents (ANA, 2018, p. 40).

After receiving the title, the user has 90 (ninety) days to complete the State Register for the Control, Monitoring and Inspection of Activities for the Exploration and Use of Water Resources (CERH), as determined by Article 15 of State Decree No. 1,227 of February 13, 2015, which states:

The State Register for the Control, Monitoring and Supervision of Activities for the Exploration and Utilization of Water Resources (CERH), which will be administered by SEMAS/PA, is compulsory for any individual or legal entity that uses water resources as an input in its production process or for the purpose of economic exploitation or utilization" and according to paragraph 1, registration in the register will not be subject to payment of a fee and will have the deadline and procedures established in an act by the head of SEMAS (Pará, 2015).

The user of water resources must access the following address www.semas.pa.gov.br/tfrh and then fill in all the information requested according to their activity, which can be "Hydro-energy Development" or "Other Activities" for all other activities exploiting water resources. When filling out the form, the user will enter the password with which they will later be able to log in to (CERH), and thus obtain their Registration Certificate, as well as register their respective uses for

each reference month, if they are a contributing activity or use more than 100m³/day, considering that there is no fractioning by grant or point of use. According to Article 6 I and II of State Decree No. 1.227/2015, residential supply and other activities or undertakings are exempt from paying the Fee for the Control, Monitoring and Inspection of Activities for the Exploration and Use of Water Resources - TFRH: any and all consumption below 100 m³/day, the calculation of which must take into account the total used by the undertaking, and fractional declaration by grant or points of abstraction or launch is not allowed (Pará, 2015).

According to article 5 of the State Decree above, the value of the TFRH will correspond to 0.2 (two tenths) of the Pará State Standard Fiscal Unit - UPFPA per m³ (cubic meter) of water resource used. For 2019, according to the website of the State Department of Finance, the value of the UPFPA is 3.4617 and enterprises that consume 100m³ or more will be managed by the equation: $TFRH=0.2 \times 3.4617 \times vol$ (Pará, 2015a).

According to article 16 and its sections of Decree 1. 227/2015, persons obliged to register with the CERH, subject to the deadline, form, periodicity and conditions established by SEMAS, will provide information on: grants for surface and/or underground water abstraction, their validity period and the conditions established therein; the effective condition of exploitation and use of water resources; the start, suspension and closure of the effective exploitation and/or use of water resources; the quantity of water resources used; the destination given to the water resources used; among others.

It is worth noting that users who have a grant and wish to renew it according to article 8 of Resolution No. 10 of September 3 of the State Water Resources Council will have six months before the grant expires to apply for renewal (Pará, 2010a).

3.3 Model of the water supply system in the university city of Prof. José da Silveira Netto

The main campus of Cidade Universitária has its own water supply system, which has been in operation since it was founded in 1957. The water treatment plant (ETA) began operating in the 1980s and is still in operation today. It was originally planned to have a capacity of three modules and an output of 240 m³/h, but two modules were developed to meet the demand of 160 m³/h (Silva, 2012). After the on-site inspection, it was found that 6 (six) wells had been built and according to Silva (2012), the wells built in the 1970s and 1980s had already been abandoned, and the wells that were active at the time were drilled in 2000, 2002 and 2003. The artesian well (P6) was drilled in 2009 with a flow rate of 200 m³/h. It serves the consumption of residents of the university town.

In Figure 5, we can see the various water supply sites on the campus of the Federal University of Pará, the Water Treatment Plant (WTP), the local concessionaire and the corresponding well sites.

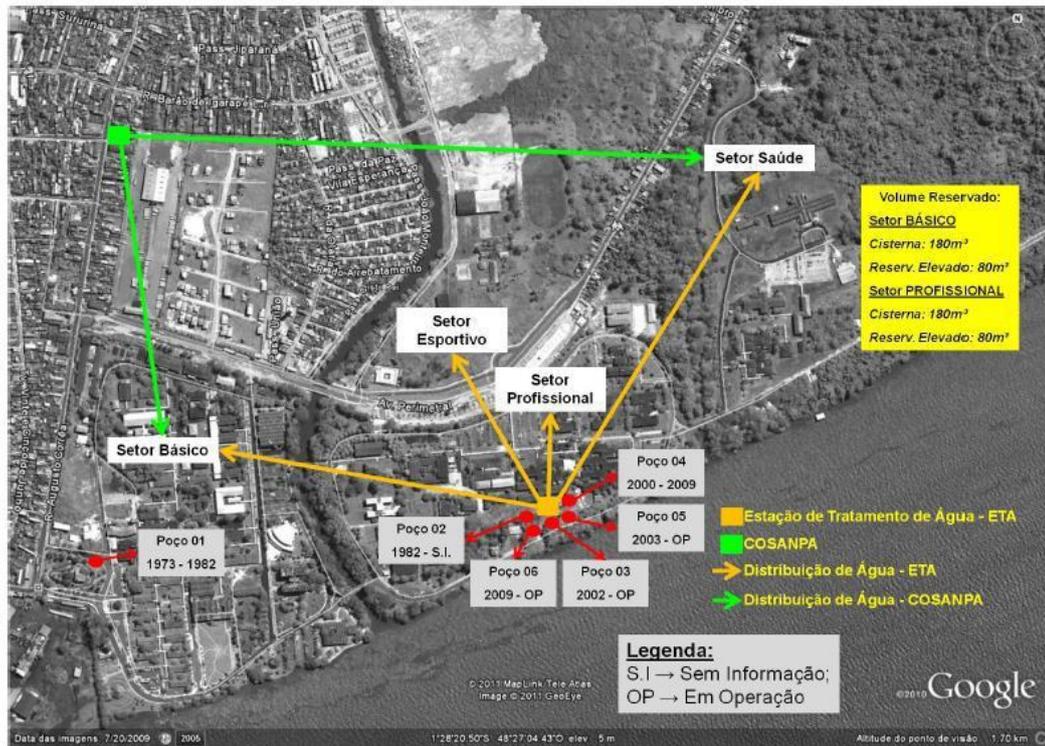


Figure 5. Water supply locations at UFPA (ETA and Local Concessionaire) and Location of Wells. Source: Silva (2012)

Water for the Guamá Campus of the Federal University of Pará (UFPA) is treated in a Water Treatment Plant (WTP). Figure 6 shows the system consisting of two plate aerators, two upward contact beds, four filters and a downward flow and chlorine disinfection system (Pereira, Silva, Sousa, 2001). The ETA/UFPA was inaugurated on July 2, 1987 and is still in operation today, treating the groundwater used to supply the basic and professional sectors of the University City. UFPA has always had a team of employees responsible for this service. The Water Treatment Plant (ETA) maintains a 24-hour service station, staffed by 4 Hydraulic Firefighters, providing outsourced services to this day (Silva, 2012).



Figure 6. Partial view of the University City water treatment plant. Source: Authors (2023)

3.4 Estimated groundwater consumption at José da Silveira Netto University City

According to UFPA's city hall, most of the buildings located in the university city do not have a water meter, which makes it difficult to measure the real consumption in each building. To estimate total demand, the value of 13.2 L/inhab.day was adopted (Cardoso, 2018). Therefore, the estimated human consumption: 811,813.2 L/day, or 811.81 m³ /day.

3.5 Environmental and sanitary conditions of the well in Use at José da Silveira Netto University City

At the time of this research, only well six (06), built in 2009, was in operation, as can be seen in Figure 7. Officials responsible for the university's supply system said that they are cleaning another well, which will be reactivated to supply the university. Currently, the well built in 2009 does not have all the necessary sanitary conditions required by the environmental agency, given that the mouth of the well is exposed to the entry of insects and rodents, among other possible sources of water pollution, and it is necessary to resolve these pending issues such as a protective sealing cap, as well as cleaning around it, placing a protective grid, to prevent vandalism, and finally the installation of water meters in the outlet pipe before any detour to monitor the volume of water captured.

Article 29 of CERH Resolution No. 3 of September 3, 2008, states that abandoned or operating wells that cause or may cause pollution or pose risks to aquifers and drilling carried out for purposes other than water extraction must be properly plugged in order to avoid accidents that contaminate or pollute aquifers. Sole paragraph. Those responsible for wells are obliged to notify the state's water resources management body of their temporary or permanent deactivation (PARÁ/2008)



Figure 7. General view of the artesian well in operation at UFPA's Campus Sede Source: Authors (2023)

According to a technical note on the plugging of tube wells, the plugging of a well should be planned and executed in such a way as to best adapt it to the local geological and hydrogeological conditions Pará (2014b). These services should be carried out by qualified professionals or companies who are familiar with tube well construction practices. Figure 8 illustrates the mouth of the well that was the subject of the research.



Figure 8. Partial view of the mouth of the artesian well. Source: Authors (2023)

In order to apply to SEMAS for the Grant of the Right to Use Water Resources, in accordance with Normative Instruction No. 03 of March 26, 2014, in its article 3, VIII (Pará, 2014), it is necessary to have an up-to-date photographic record of the point(s) of abstraction or release or of the sites of intervention in terms of hydraulic works, as shown in Figure 9.

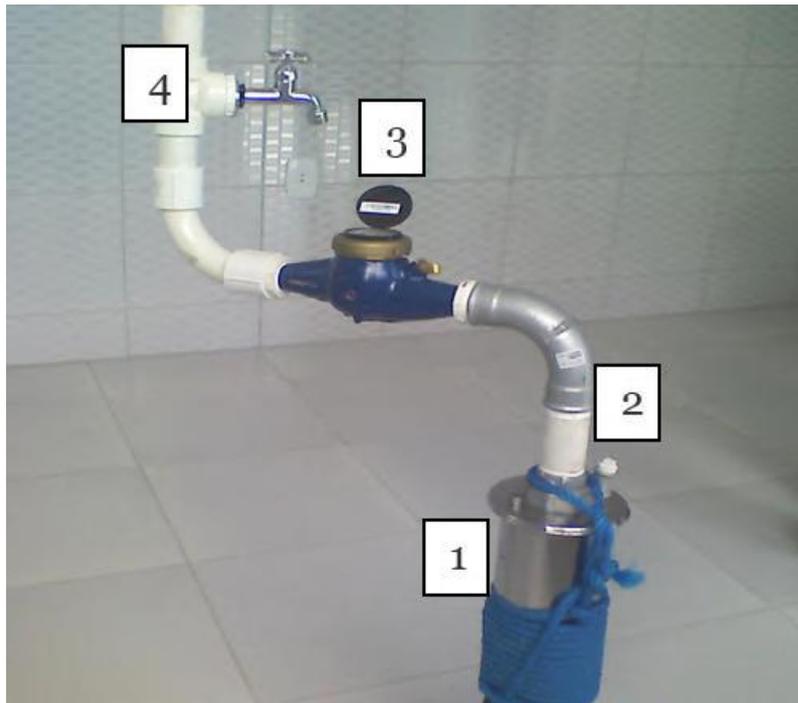


Figure 9. Photographic model of the installation of the devices for granting the artesian well. Source: Alagoas (2016)

It is important that the artesian well has all the devices installed and in the required sequences, because the water resources policy is already consolidated, it obliges users who collect water for various purposes to have the appropriate

sanitary conditions and to follow the procedures to be legalized before the environmental agency.

According to the model above, we have the following items: 1 is the well; 2 is the device for reading and analyzing the well; 3 is the hydrometer for measuring the flow of the well and 4 is the tap, which is the device for collecting water.

3.6 Analysis of the environmental quality of well water in use in José da Silveira Netto University City

According to Report No. 2018/09-11823 issued by the company MULTIANÁLISES (2018), the samples collected directly from the artesian well in relation to microbiological analysis, showed an absence of Total Coliforms and *Escherichia coli* and in relation to the physical-chemical parameters showed changes in apparent color, turbidity and total iron, that is, the results are in disagreement with Environmental Legislation, at the maximum allowed value (VMP), according to consolidation ordinance No. 5 of 03/10/2017 MS. However, in studies carried out by researcher Beatriz Bentes in 2015 in her work *Quantification of Physical-Chemical Parameters and Metals in Water Consumed in the University City "Professor José da Silveira Netto" - Belém (PA)*, the results obtained for the collection points were always below the maximum values allowed by legislation, with the exception of turbidity with values respectively of 13.55 mg. L⁻¹ ; 31.50 mg.L⁻¹ ; 5.38 mg.L⁻¹ ; 6.13 mg.L⁻¹ and 5.55 mg.L⁻¹ (acceptable value ≤ 5 uT) and pH for groundwater with an average of 4.9 (acceptable value between 5.5 and 8.5), in general the results obtained by this researcher indicated that the water quality is adequate, based on the environmental parameters analyzed.

In 2021, the researchers Brito et al. (2021, p. 81), carried out a study on the quality of the groundwater used in the professional sector of the university city Prof. José da Silveira Netto-UFPA, after analyzing the water from the wells of the professional sector of UFPA, were able to ascertain that all the points monitored are within the standards measured by Ordinance No. 888 of 2021 of the Minister of Health (SM). The resulting physical-chemical variables of apparent color and free residual chlorine are above and below the specified limits, respectively.

These factors may indicate the presence of dissolved solids such as iron and manganese in the water, and low concentrations of chlorine may not eliminate potential pathogens that can transmit waterborne diseases through contaminated water. The researchers also found that the vast majority of the water from the wells complied with the regulations when it came to the total number of total coliform bacteria, which indicates contamination of the water by microbiological factors. However, samples were taken and the analytical results show that they are outside the standard for some devices, requiring constant and routine monitoring, as several people consume drinking water in these places, indicating a direct threat to the university community (Brito et al. 2021, p. 81 and 82).

When water is consumed without treatment, it becomes a potential health risk. The University therefore has a Water Treatment System (WTP), so that drinking water is readily available.

3.7 Water use flowchart

As can be seen in the flowchart shown below in Figure 10, the water is collected from the well, directed to the water treatment plant in the university city and after treatment, it is directed to the water tank and then to the water distribution network and finally to the sectors.



Figure 10. Flowchart of water use in the University City sectors Source: Authors (2023)

3.8 Production test of the well in use at José da Silveira Netto University City

According to the FEMAC technical report (2009), the pumping test was carried out with an EBARA model BHS 804-2 submersible electric pump with a 40 HP motor, installed at a depth of 54 meters with a 6" diameter galvanized iron pipe pumping column. Flow measurements were made in an iron tank with a volume of 3,300 liters and an electronic level gauge was used to measure the well's water level. According to FEMAC (2009, p. 12), in Table 1, the production test was carried out in the staggered type with 3 progressive flow stages, keeping the flow constant at each stage. The total duration of the test was 24 hours, with 8 hours for each flow stage.

Table 1. Staggered well production test

Production testing			
Static level (ne): 8.71 m		Pumping time: 24 hours	
Dynamic level (nd): 23.44 m		Maximum flow: 212.12 m ³ /h	
Stage	Flow (m ³ /h)	Dynamic level (m)	Lowering (m)
1	94,29	14,42	5,74
2	154,29	18,76	10,05
3	212,14	23,44	14,73

Source: Femac - GeoSolo Engenharia Ltda (2009)

At the end of the test, the pump was switched off and the level recovery test was carried out, as shown in Table 2 below. (FEMAC, 2009):

Table 2. Data obtained from the level recovery test

Level recovery test		
Static level (ne): 8.71 m		Test duration: 2 hours
Time (min)	Dynamic level (m)	Lowering (m)
0	23,44	14,73
1	9,31	0,60
2	9,16	0,45
3	9,09	0,38
4	9,05	0,34
5	9,02	0,31
10	8,97	0,26
20	8,95	0,24
30	8,90	0,19
45	8,86	0,15
60	8,81	0,10
90	8,78	0,07
120	8,73	0,02

Source: Femac - GeoSolo Engenharia Ltda (2009)

According to Cooper and Jacob (1946), the drawdown in a pumped well approximately follows the characteristic equation below:

$$s = BQ + CQ^2$$

Being:

s is the drawdown, measured at the well being pumped in meters(m);

B is the loss coefficient of the aquifer;

C is the loss coefficient of the well;

Q is the flow rate (m³/h)

The BQ term represents the drawdown due to aquifer losses and the CQ² term represents the over drawdown due to the well's head losses. Therefore, the above equation can be written from the results obtained in the staggered production test, as shown in Table 3, where the values of s, corresponding to each pumping stage, were taken at equal time intervals (8h), from the start of each stage and always referred to the static level (FEMAC, 2009).

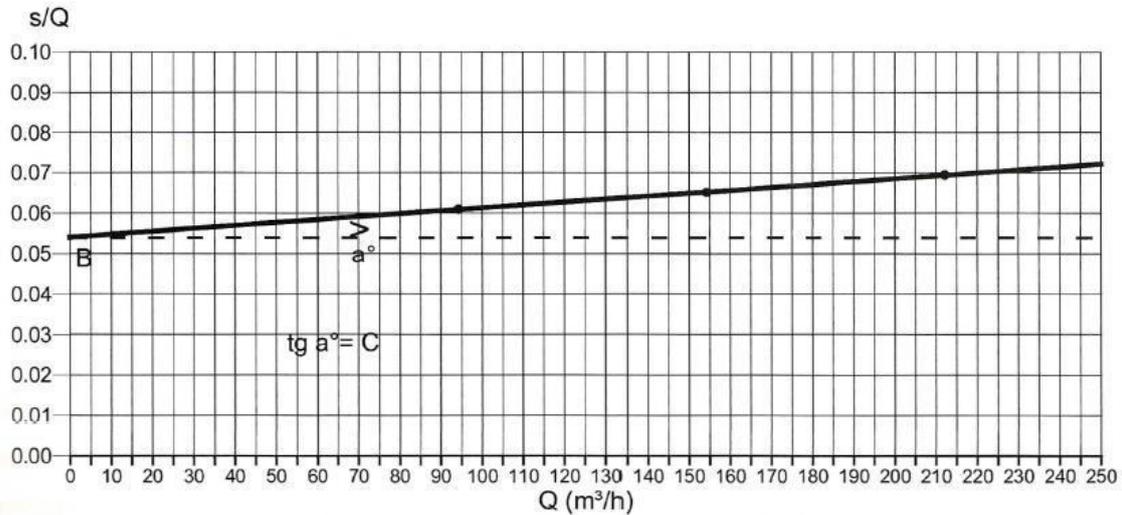
Table 3. Scaled test results

Stage	Q (m ³ /h)	S (m)	S/q (m/m ³ /h)
1	94,29	5,74	0,0609
2	154,29	10,05	0,0651
3	212,14	14,73	0,0694

Source: Femac - GeoSolo Engenharia Ltda (2009)

Graph 1 shows the specific drawdown x flow rate.

Graph 1 - Specific lowering x flow rate



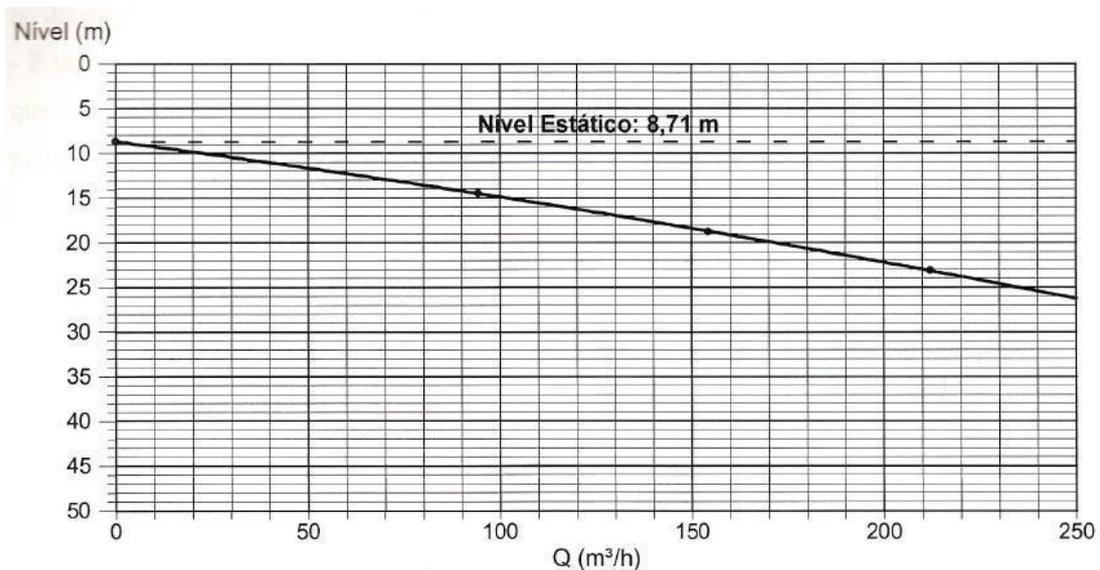
Source: Femac - GeoSolo Engenharia Ltda (2009)

Therefore, according to Femac (2019), the B and C coefficients of the graph were extracted from the characteristic curve of the well, obtaining:

$$B = 0,0054; C = (0,072-0,054) / 250 = 0,000072.$$

The well's characteristic equation is: $s = 0.054Q + 0.00072Q^2$. The well's characteristic curve, based on the production test data, is shown in Graph 2 (FEMAC, p.14):

Graph 2 - Well Characteristic Curve



Source: Femac - GeoSolo Engenharia Ltda (2009)

According to FEMAC (2009, p.15), the joint analysis of the Equation and the Well Characteristics Curve leads to the conclusion:

a) The coefficient C is close to zero, meaning that the well's pressure losses are negligible, indicating that it is well constructed.

b) The Characteristic Curve shows that the well can be operated with a flow rate higher than the final test flow rate (212.14 m³/h), since the "critical point", from which the increase in drawdown is quite disproportionate to small increases

in flow rate, has not been reached.

It is recommended that the maximum pumping flow rate of the well does not exceed 250 m³/h, approximately 20% more than the maximum obtained in the Production Test. The increase in flow corresponds to a higher speed of water flow through the filter slots and an increase in the differential pressure in the filter/pre-filter contact, which can revolve the grains of the pre-filter and the sand layers adjacent to it, destabilizing and altering the conditions obtained in the cleaning and development process, and may cause the finer grains of sand from the aquifers to be carried into the well (FEMAC, 2009, p.15).

Also according to Femac-Geosolo Engenharia Ltda (2009), it is advisable that the daily operation of the well does not exceed a maximum period of 16 hours, leaving at least 8 hours for level recovery, which will reduce the loss of specific flow over the course of its operation, as well as recommending that the well be cleaned and disinfected at least every 2 years, so that there is no loss of water quality and reduced flow caused by incrustations that may appear on the well's filters.

Although the well was built in compliance with the best environmental conditions, achieving the objective of producing water, it is subject to mechanical, chemical, biological and geological problems. Currently, the well does not have all the necessary environmental and sanitary conditions required by the environmental agency in order to be granted the right to use water resources, and this must be remedied because it is compromising the well's safety, which risks contaminating its aquifer.

Environmental management measures will have to be taken with regard to the waste of exploited water, as there is a greater consumption of unnecessary energy to drive the pump, and the aerator and components of the water supply system will have to be corrected.

With regard to wells that are inoperative, it is advisable to plug them, which are procedures used to fill in a well with cement grout, bentonite, gravel or other inert materials in order to re-establish the aquifer's original conditions and prevent contamination of the aquifer underground.

4 Final considerations

The Granting of the Right to Use Water Resources ensures that human activities are carried out in a scenario of sustained socio-economic development, ensuring the availability of water resources to current users and future generations, at adequate standards of quality and quantity, including the maintenance of life.

Currently, the José da Silveira Netto University City, home to UFPA, does not have a Right of Use Grant issued by the responsible environmental agency. This situation can cause immeasurable damage to the environment, as well as sanctions for the institution and the imposition of warnings, fines, provisional embargoes and definitive embargoes.

According to the results of this research into the current environmental management conditions of the well, it was found that it is not fully suitable to apply for a water resources use grant from SEMAS/PA, as it does not meet the standard requirements of the environmental agency, due to technical and sanitation problems. Because the well's mouth is exposed to insects and rodents, among other possible sources of water pollution, these pending issues need to be resolved, such as a protective sealing cap, as well as cleaning around it, placing a protective grid to prevent vandalism, and finally, installing water meters in the outlet pipe before any detour, to monitor the volume of water captured. The inoperative wells will also have to be plugged in order to re-establish the aquifer's original conditions and prevent contamination through the well.

In view of what has been identified, we recommend that, in accordance with the diagnosis carried out for the distribution of water supply to the University City, Prof. José da Silveira Netto-UFPA, as a scientific and management contribution, some basic guidelines should be implemented to solve the problems encountered: the implementation of a model for granting the right to use water resources, in order to meet this requirement, there was an urgent need to suggest

to the Institution's top administrator, in order to legalize such non-compliant situations; the appointment of a multidisciplinary team of professionals, legally qualified, preferably with the presence of a professional in the area of geology and chemistry, to work first to resolve the current irregularities in the well, because the well's safety is at risk, as well as the plugging procedure for inoperative wells, and then to start the regularization process, in order to comply with current legislation, as well as all the technical conditions proposed by the responsible environmental agency; replacement of deep-water well filters based on the manufacturer's expiry date; replacement of wells in a degraded state; implementation of improvements in the Water Treatment Plant (WTP) operating process, as it was found that some analyses of drinking water showed that some parameters in the plant's water had geochemical background values higher than the standards recommended by the relevant legislation; it was suggested that the dosage of free residual chlorine be monitored; and finally that a plan be set up for constant monitoring of the environmental quality of the water supplied by the drinking fountains to the community and a methodological procedure for implementing the sampling plan be assembled.

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Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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